

CERTIFICATE

By Authority Of THE UNITED STATES OF AMERICA Legally Binding Document

By the Authority Vested By Part 5 of the United States Code § 552(a) and Part 1 of the Code of Regulations § 51 the attached document has been duly INCORPORATED BY REFERENCE and shall be considered legally binding upon all citizens and residents of the United States of America. HEED THIS NOTICE: Criminal penalties may apply for noncompliance.



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AHRI Standard 320-98
(Formerly ARI Standard 320-98)

1998 Standard for
Water-Source Heat Pumps



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IMPORTANT <i>SAFETY RECOMMENDATIONS</i>

It is strongly recommended that the product be designed, constructed, assembled and installed in accordance with nationally recognized safety requirements appropriate for products covered by this standard.

AHRI, as a manufacturers' trade association, uses its best efforts to develop standards employing state-of-the-art and accepted industry practices. However, AHRI does not certify or guarantee safety of any products, components or systems designed, tested, rated, installed or operated in accordance with these standards or that any tests conducted under its standards will be non-hazardous or free from risk.

ARI CERTIFICATION PROGRAM PROVISIONS

Scope of the Certification Program

The certification program includes water-source heat pumps that are electrically driven, mechanical compression type systems as defined in the standard and included in this program.

Equipment Covered: This program applies only to water-source heat pumps, rated below 135,000 Btu/h [40 kW] at AHRI Standard Rating Conditions (Cooling).

Exclusion: This certification program does not apply to the rating and testing of individual assemblies, such as condensing units or coils, for separate use.

Certified Ratings

The following certification program ratings are verified by test:

1. Cooling Capacity, Btu/h [W]
2. EER, Btu/w·h [W/W]
3. Heating Capacity, Btu/h [W]
4. COP, W/W

Note:

This standard supersedes ARI Standard 320-93.

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WATER-SOURCE HEAT PUMPS

Section 1. Purpose

1.1 Purpose. The purpose of this standard is to establish for water-source heat pumps: definitions and classifications; requirements for testing and rating; performance requirements; marking and nameplate data; and conformance conditions.

1.1.1 This standard is intended for the guidance of the industry, including manufacturers, engineers, installers, contractors and users.

1.1.2 Review and Amendment. This standard is subject to review and amendment as technology advances.

Section 2. Scope

2.1 Scope. This standard applies to factory-made residential, commercial and industrial water-source heat pumps, as defined in Section 3.

2.1.1 Energy Source. This standard applies only to electrically-driven, mechanical compression type systems.

2.1.2 Alternative Applications. Equipment designed for rating under this standard may not be suitable for alternative applications covered in related AHRI Standards 325 and 330.

2.2 Exclusions. This standard does not apply to individual assemblies for separate use.

Section 3. Definitions

3.1 Definitions. All terms in this document will follow the standard industry definitions in the current edition of ASHRAE *Terminology of Heating, Ventilation, Air-Conditioning and Refrigeration* unless otherwise defined in this section.

3.2 Coefficient of Performance (COP). A ratio of the heating capacity in watts [W], excluding supplementary resistance heat, to the power input in watts [W] at any given set of rating conditions expressed in watts/watt [W/W]. (The international community uses the term EER as equivalent to cooling COP.)

3.2.1 Standard Coefficient of Performance. A ratio of the capacity to power input obtained at Standard Rating Heating Conditions.

3.3 Cooling Capacity. The total heat-removal capacity is the sum of the sensible and latent heat-removal capacities expressed in Btu/h [W].

3.3.1 Sensible Heat. Heat associated with a change in dry-bulb temperature.

3.3.2 Latent Heat. The change of enthalpy during a change of state. It occurs with no change in dry-bulb temperature.

3.4 Energy Efficiency Ratio (EER). A ratio of the cooling capacity in Btu/h [W] to the power input in watts [W] at any given set of rating conditions, expressed in Btu/W·h [W/W].

3.4.1 Standard Energy Efficiency Ratio. A ratio of the capacity to power input values obtained at Standard Rating Conditions.

3.5 Published Rating. A statement of the assigned values of those performance characteristics, under stated rating conditions, by which a unit may be chosen to fit its application. These values apply to all units of like nominal size and type (identification) produced by the same manufacturer. As used herein, the term “published rating” includes the rating of all performance characteristics shown on the heat pump or published in specifications, advertising or other literature controlled by the manufacturer, at stated rating conditions.

3.5.1 Standard Rating. A rating based on tests performed at Standard Rating Conditions.

3.5.2 Application Rating. A rating based on tests performed at application rating conditions (other than Standard Rating Conditions).

3.6 Rating Conditions. Any set of operating conditions under which a single level of performance results, and which causes only that level of performance to occur.

3.6.1 Standard Rating Conditions. Rating conditions used as the basis of comparison of performance characteristics.

3.7 “Shall,” “Should,” “Recommended” or “It Is Recommended.” “Shall,” “should,” “recommended” or “it is recommended” shall be interpreted as follows:

3.7.1 Shall. Where “shall” or “shall not” is used for a provision specified, that provision is mandatory if compliance with the standard is claimed.

3.7.2 Should, Recommended or It Is Recommended. “Should,” “recommended” or “it is recommended” is used to indicate provisions which are not mandatory but which are desirable as good practice.

3.8 Standard Air. Air weighing 0.075 lb/ft³ [1.2 kg/m³] which approximates dry air at 70°F [21.1°C] and at a barometric pressure of 29.92 inches of mercury [101.1 kPa].

3.9 Water-Source Heat Pump. A water-source heat pump is typically one of multiple units using fluid circulated in a common piping loop as a heat source/heat sink. The temperature of the loop fluid is usually mechanically controlled within a moderate temperature range of 60°F to 90°F [15.5° C to 32.2°C]. The heat pump consists of one or more factory-made assemblies which normally include an indoor conditioning coil with air moving means, compressor(s) and refrigerant-to-water heat exchanger(s), including means to provide both cooling and heating or cooling only functions. When such equipment is provided in more than one assembly, the separated assemblies shall be designed to be used together, and the requirements of rating outlined in the standard are based upon the use of matched assemblies.

3.9.1 Functions. Water-source heat pumps shall provide the function of air-circulating and cooling and heating with controlled temperature, and may include the functions of water heating, air-cleaning, dehumidifying or humidifying.

Models could be designated as “cooling only” units as an option of a water-source heat pump and need not include the heating function provided the following are met:

- The components of the air-conditioning refrigerant system (cooling system) are substantially the same as the corresponding heat pump system.
- Switches, thermostats and/or other controls of electrical components required for the reverse cycle heating mode can be altered or deleted as required to provide cooling only.
- All other chassis components, fans, motors, pumps, housings, etc., must be substantially the same between both versions.

Section 4. Classification

5.1.3 Standard Rating Conditions. The conditions of test for Standard Ratings shall include the following:

4.1 Classification. Normally, water-source heat pumps within the scope of this standard may be classified as shown in Table 1.

Table 1. Classification of Water-Source Heat Pumps			
Types of Water-Source Heat Pumps			
Designation	ARI Type	*Arrangement	
Single Package (Ducted)	HSP-W	FAN EVAP	COMP COND
Split System (Ducted)	HRCU-W	FAN EVAP	COMP COND
Single Package (Free Delivery)	HSP-W-O	FAN EVAP	COMP COND
Split System (Free Delivery)	HRCU-W-O	FAN EVAP	COMP COND
*Denotes cooling mode function.			

Section 5. Testing and Rating Requirements

5.1 Standard Rating. Standard ratings shall be established at the Standard Rating Conditions specified in 5.1.3. All standard ratings shall be verified by tests conducted in accordance with ASHRAE Standard 37, and with the test methods and procedures as described in this standard except that the total cooling and heating capacity shall be the average of the Air-Enthalpy Method and the Water Coil Method.

Standard Ratings relating to cooling or heating capacities shall be net values, including the effects of circulating-fan heat, but not including supplementary heat. Standard Input Ratings shall be the total power input to the compressor(s) and fan(s), plus controls and other items included as part of the model number(s).

5.1.1 Values of Standard Capacity Ratings. These ratings shall be expressed in Btu/h [W] in multiples of 100 Btu/h [10 W].

5.1.2 Values of Standard Energy Efficiency Ratio or Coefficients of Performance. Standard ratios of energy efficiency for cooling, whenever published shall be expressed in multiples of the nearest 0.1 Btu/W·h [cooling COP in multiples of 0.1] standard coefficients of performance for heating whenever published shall be expressed in multiples of the nearest 0.1.

5.1.3.1 Standard Rating Temperatures.

a. *Cooling.*

Air temperature entering indoor portion
of unit.....80°F [26.7°C] dry bulb
67°F [19.4°C] wet bulb
Air temperature surrounding
unit.....80°F [26.7°C] dry bulb
Water temperature entering
refrigerant-to-water
heat exchanger.....85°F [29.4°C]
Water temperature leaving
refrigerant-to-water
heat exchanger.....95°F [35.0°C]

b. *Heating (not required for cooling only models).*

Air temperature entering indoor portion
of unit.....70°F [21.1°C] dry bulb
60°F [15.6°C] wet bulb, max.
Air temperature surrounding
unit.....70°F [21.1°C] dry bulb
Water temperature entering
refrigerant-to-water
heat exchanger.....70°F [21.1°C]
Water flow rate.....as determined in
Standard Rating
Cooling Test

5.1.3.2 Electrical Conditions. Standard Rating tests shall be performed at the nameplate rated voltage(s) and frequency.

For heat pumps with dual nameplate voltage ratings, Standard Rating tests shall be performed at both voltages, or at the lower of the two voltages, if only a single Standard Rating is to be published.

5.1.3.3 Indoor-Side Air Quantity. All Standard Ratings shall be determined at an indoor-side air quantity, delivered against at least the minimum external resistance required by 5.1.3.5 as outlined in Table 2. All air quantities shall be expressed as cfm [m³/s] of Standard Air (density 0.075 lb per cu ft [1.2 kg/m³]).

- a. Heat pumps shall be rated at the indoor-side air quantity delivered when operating against the minimum external resistance specified in 5.1.3.5 or at a lower indoor-side air quantity, if so specified by manufacturer.

Indoor-side air quantities as referred to herein apply to the air quantity experienced when the unit is cooling and dehumidifying under the Standard Rating Cooling Conditions specified in this section. This air quantity, except as noted in 6.3, shall be employed in all other tests prescribed herein without regard to resulting external static pressure, or if so specified by the manufacturer the air quantity employed in all of the tests shall be that achieved at the external resistance employed in Standard Rating Cooling test.

5.1.3.4 Requirements for Separated Assemblies. All Standard Ratings for heat pumps in which the outdoor section is separated from the indoor section, as in Type HRCU (shown in Section 4), shall be determined with at least 25 ft. [7.62 m] of interconnection tubing on each line, of the size recommended by the manufacturer. Such heat pumps in which the interconnection tubing is furnished as an integral part of the machine not recommended for cutting to length shall be tested with the complete length of tubing furnished, or with 25 ft. [7.62 m] of tubing, whichever is greater. The line sizes, insulation and details of installation shall be in accordance with the manufacturer's published recommendations.

5.1.3.5 Minimum External Resistances. Indoor air-moving equipment intended for use with field installed duct systems shall be designed to operate against, and tested at not less than, the minimum external resistance shown in Table 2 when delivering the rated capacity and air quantity specified in 5.1.3.3. Indoor air-moving equipment not intended for use with field installed duct systems shall be tested at 0 in. of H₂O [0 kPa] external pressure.

In interpreting this requirement, it is understood that the most restrictive filters, supplementary heating coils and other equipment recommended as optional parts of the heat pump be in place and that the next external resistances specified in Table 2 above are available for the external duct system.

Table 2. Minimum External Resistance

Standard Cooling Capacity Ratings		Minimum External Resistance	
Btu/h x 1000	[kw]	In. of H ₂ O	[kPa]
Up thru 28.9	Up thru 8.4	0.10	0.025
29 thru 42.9	8.5 thru 12.5	0.15	0.037
43 thru 70.9	12.6 thru 20.7	0.20	0.050
71 thru 105.9	20.8 thru 31.0	0.25	0.062
106 thru 134.9	31.1 thru 39.5	0.30	0.075
135 thru 210.9	39.6 thru 61.7	0.35	0.087
211 thru 280.9	61.8 thru 82.2	0.40	0.100
281 thru 350.9	82.3 thru 102.8	0.45	0.112
351 thru 400.9	102.9 thru 117.4	0.55	0.137
401 thru 500.9	117.5 thru 146.7	0.65	0.162
501 and over	146.8 and over	0.75	0.187

5.2 Part-Load Rating. Heat pumps which are capable of capacity control shall be rated at each step of capacity reduction provided by the heat pump and allowed by the controls.

5.2.1 Part-Load Rating Conditions. The conditions of test for part-load ratings are the same as for the Standard Ratings (see 5.1) except for the following:

5.2.1.1 Part-Load Rating Temperatures (Cooling).

Air temperature entering indoor portion
of unit.....80°F [26.7°C] dry bulb
67°F [19.4°C] wet bulb
Water temperature entering refrigerant-
to-water heat exchanger.....75°F [23.9°C]
Water flow rate.....as determined in Standard
Rating Cooling Test

5.2.1.2 Part-Load Rating Temperatures (Heating—not required for cooling only models).

Air temperature entering indoor portion
of unit.....70°F [21.1°C] dry bulb
60°F [15.6°C] wet bulb max.
Air temperature surrounding
unit.....70°F [21.1°C] dry bulb
Water temperature entering refrigerant-
to-water heat exchanger.....75°F [23.9°C]
Water flow rate.....as determined in Standard
Rating Cooling Test

6.2.1 Temperature Conditions.

5.2.1.3 The capacity reduction means may be adjusted to obtain the specified step of unloading. No manual adjustment of indoor air quantities from those of standard rating conditions shall be made. Automatic adjustment of the quantities by system function, however, is permissible.

5.3 Application Ratings. Ratings at conditions of air/water temperature or air/water quantity other than those specified in 5.1.3 and 5.2.1, may be published as application ratings, and shall be based on data determined by the methods prescribed in 5.1.

5.4 Publication of Ratings. Wherever application ratings are published or printed, they shall include, or be accompanied by, the Standard Capacity Ratings plus the Part-Load Rating (where applicable), and their corresponding power inputs, clearly designated as such, including a statement of the conditions at which the ratings apply.

5.4.1 Capacity Designation. The capacity designation used in published specifications, literature or advertising, controlled by the manufacturer, for heat pumps rated under this standard, are to be expressed only in Btu/h [W] at the Standard Rating Conditions specified in 5.1.3 plus Part-Load Rating Conditions specified in 5.2.1 and in the terms described in 5.1.1 through 5.1.2. Horsepower, tons or other units shall not be used as capacity designations.

5.5 Tolerances. To comply with this standard published cooling capacity ratings, heating capacity ratings, ratios of energy efficiency for cooling and coefficients of performance for heating shall be based on data obtained in accordance with the provisions of this section, and shall be such that any production unit, when tested, will meet or exceed these ratings except for an allowance to cover testing and manufacturing variations: the amount of allowance to be minus 5 percent.

Section 6. Performance Requirements

6.1 Performance Requirements. To comply with this standard, water-source heat pumps shall be designed and produced in accordance with the provisions of this section in such a manner that any production unit will meet the requirements detailed herein.

6.2 Maximum Operating Conditions Test. Water-source heat pumps shall be designed and produced to pass the following maximum operating conditions test with an indoor-side coil air quantity as determined under 5.1.3.3:

6.2.1.1 Cooling.

Air temperature surrounding
unit.....95°F [35.0°C] dry bulb
Air temperature entering
indoor portion
of unit.....95°F [35.0°C] dry bulb
71°F [21.7°C] wet bulb
Water temperature entering
refrigerant-to-water
heat exchanger.....95°F [35°C]
Water flow rate.....maintained same
as in 5.1.3.1

6.2.1.2 *Heating (not required for cooling only models).*

Air temperature entering
indoor portion
of unit.....80°F [26.7°C] dry bulb
Air temperature surrounding
unit.....80°F [26.7°C] dry bulb
Water temperature entering
refrigerant-to-water
heat exchanger.....90°F [32.3°C]
Water flow rate.....maintained same
as in 5.1.3.1

6.2.2 *Voltages.*

6.2.2.1 Tests shall be run at 90 percent and 110 percent of the unit's nameplate rated voltage at the unit's service connection and at rated frequency, or at a lower than 90 percent minimum or a higher than 110 percent maximum voltage if listed on the nameplate.

6.2.2.2 The power supplied to the heat pump shall be adjusted just prior to the shut down period (see 6.2.3.2) so that the resulting voltage at the unit's service connection is 86 percent of nameplate rated voltage when the compressor is on locked rotor. (For those dual voltage units so specified on their specification sheets for a minimum voltage 5 percent below the lower rated voltage, this locked-rotor voltage setting shall be 91 percent of the lower rated voltage.)

6.2.2.3 Within one minute after the heat pump has resumed continuous operation (see 6.2.4.3), the voltage shall be restored to the values specified in 6.2.2.1.

6.3.2 *Procedure.* The test shall be continuous with the unit on the cooling mode, for not less than four hours after establishment of the specified temperature conditions. The unit will be permitted to operate under the control of a limit device, if provided.

6.2.2.4 Single phase dual voltage units whose lower voltage is 208V, which specify on their specification sheets a minimum voltage to be applied at the unit service connection for the maximum operating conditions test, shall be tested at the lower of this minimum voltage or 198V in accordance with 6.2.2.1, 6.2.2.2 and 6.2.2.3.

6.2.3 *Procedure.*

6.2.3.1 The heat pump shall be operated for two hours at the temperature conditions and voltage(s) specified.

6.2.3.2 All power to the heat pump shall be cut off for a period sufficient to cause the compressor to stop (not to exceed five seconds) and then restored.

6.2.4 *Requirements.*

6.2.4.1 During both entire tests, the heat pump shall operate without failure of any of its parts.

6.2.4.2 The heat pump shall operate continuously without interruption for any reason for the two-hour period preceding the power interruption.

6.2.4.3 The unit shall resume continuous operation within two hours of restoration of power and shall then operate continuously for one hour. Operation and resetting of safety devices prior to establishment of continuous operation is permitted.

6.3 *Low-Temperature Operation Test (Cooling).* Water-source heat pumps shall be designed and produced to pass the following low-temperature operation test when operating with initial air quantities as determined in 5.1.3.3 and with controls and dampers set to produce the maximum tendency to frost or ice the evaporator, provided such settings are not contrary to the manufacturer's instructions to the user:

6.3.1 *Temperature Conditions.*

Air temperature entering indoor portion
of unit.....67°F [19.4°C] dry bulb
57°F [13.9°C] wet bulb
Water temperature entering refrigerant-
to-water heat exchanger.....65°F [18.3°C]
Water flow rate..... maintained same
as in 5.1.3.1

6.3.3 *Requirements.*

6.3.3.1 During the entire test, the heat pump shall operate without damage to the equipment.

6.3.3.2 During the entire test, the air quantity shall not drop more than 25 percent from that determined under the Standard Rating Cooling Test.

6.3.3.3 During the test, and during the defrosting period after the completion of the test, all ice or meltage must be caught and removed by the drain provisions.

6.3.3.4 For a dual voltage unit, unit shall operate continuously at the lower voltage.

6.4 Insulation Efficiency Test (Cooling). Water-source heat pumps shall be designed and produced to pass the following insulation efficiency test when operating with air quantities as determined in 5.1.3.3 with controls, fans, dampers and grilles set to produce the maximum tendency to sweat, provided such settings are not contrary to the manufacturer's instructions to the user.

6.4.1 Temperature Conditions.

Air temperature entering and
surrounding indoor
portion of unit.....80°F [26.7°C] dry bulb
75°F [23.9°C] wet bulb
Water temperature entering refrigerant-
to-water heat exchanger.....80°F [26.7°C]
Water flow rate.....maintained same
as in 5.1.3.1

6.4.2 Procedure. After establishment of the specified temperature conditions, the unit shall be operated continuously for a period of four hours.

6.4.3 Requirements.

6.4.3.1 During the test, no condensed water shall drop, run or blow off from the unit casing.

6.4.3.2 For a dual voltage unit, unit shall operate continuously at the lower voltage.

6.5 Tolerances. The conditions for the tests outlined in 6.2, 6.3 and 6.4 are average values subject to tolerances of $\pm 1.0^\circ\text{F}$ [$\pm 0.6^\circ\text{C}$] for air wet bulb and dry bulb temperatures, $\pm 0.5^\circ\text{F}$ [$\pm 0.3^\circ\text{C}$] for water temperatures and ± 1.0 percent of the reading for voltages.

Section 7. Marking and Nameplate Data

7.1 Nameplate Data. The nameplate shall display the manufacturer's name, model designation, and electrical characteristics.

Recommended nameplate voltages for 60 Hertz systems shall include one or more of the equipment nameplate voltage ratings shown in Table 1 of ARI Standard 110. Recommended nameplate voltages for 50 Hertz systems shall include one or more of the utilization voltages shown in Table 1 of IEC Standard Publication 38.

Section 8. Voluntary Conformance

8.1 Conformance. While conformance with this standard is voluntary, conformance shall not be claimed or implied for products or equipment within its *Purpose* (Section 1) or *Scope* (Section 2) unless such claims meet all of the requirements of the standard.

APPENDIX A. REFERENCES - NORMATIVE

A1 Listed here are all standards, handbooks and other publications essential to the formation and implementation of the standards. All references in this appendix are considered as part of the standard.

A1.1 AHRI Standard 110-97 (formerly ARI Standard 110-97), *Air-Conditioning and Refrigerating Equipment Nameplate Voltages*, 1997, Air-Conditioning, Heating, and Refrigeration Institute, 2111 Wilson Blvd., Suite 500, Arlington, VA 22201, U.S.A.

A1.2 ASHRAE Standard 37-1988, *Methods of Testing Unitary Air-Conditioning and Heat Pump Equipment*, 1988, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Circle N.E., Atlanta, GA 30329, U.S.A.

A1.3 *ASHRAE Terminology of Heating, Ventilation, Air-Conditioning and Refrigerating*, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Circle N.E., Atlanta, GA 30329, U.S.A.

A1.4 IEC Standard Publication 38, *IEC Standard Voltages*, 1983, International Electrotechnical Commission, 3, rue de Varembe, P.O. Box 131, 1211 Geneva 20, Switzerland.

APPENDIX B. REFERENCES - INFORMATIVE

B1. Listed here are standards, handbooks and other publications which may provide useful information and background but are not considered essential. References in this appendix are not considered part of the standard.

B1.1 AHRI Standard 325-98 (formerly ARI Standard 110-97), *Ground Water-Source Heat Pumps*, 1998, Air-Conditioning, Heating, and Refrigeration Institute, 2111 Wilson Blvd., Suite 500, Arlington, VA 22201, U.S.A.

B1.2 AHRI Standard 330-98 (formerly ARI Standard 110-97), *Ground-Source Closed-Loop Heat Pumps*, 1998, Air-Conditioning, Heating, and Refrigeration Institute, 2111 Wilson Blvd., Suite 500, Arlington, VA 22201, U.S.A.